CLAIMS

We claim:

1. A system for controlling operation of a tool, the system comprising:

   a sensor adapted to detect at least one operational parameter of the tool and outputting at least one signal representing the at least one operational parameter;

   means for processing the at least one signal to detect at least one frequency of the operational parameter; and

   means for controlling the operation of the tool in response to the at least one frequency of the operational parameter.

2. The system as recited in claim 1, wherein the at least one frequency comprises a plurality of frequencies.

3. The system as recited in claim 2, wherein the plurality of frequencies comprises a range of frequencies.

4. The system as recited in claim 1, wherein the means for processing the at least one signal to detect the at least one frequency comprises software adapted to determine the frequency of the at least one operational parameter.

5. The system as recited in claim 1, wherein the means for controlling the operation of the tool comprises means for detecting the activity of at least one of the operational parameter and the frequency of the operational parameter.

6. The system as recited in claim 5, wherein the activity of at least one of the operational parameter and the frequency of at least one of the operational parameter comprises a numerical characteristic of at least one of the operational parameter and the frequency of the operational parameter.

7. The system as recited in claim 6, wherein the numerical characteristic comprises at least one of amplitude, mean, variance, standard deviation, and spectral energy density.

8. The system as recited in claim 5, wherein the means for controlling the operation of the tool comprises means for comparing the numerical characteristic to a threshold value for the numerical characteristic.

9. The system as recited in claim 1, wherein the means for controlling the operation of the tool comprises at least one of means for stopping the operation of the tool, means to slow the advancement of the tool, means for stopping the advancement of the tool, and means for moving the tool.

10. The system as recited in claim 1, wherein the tool operates on a work piece comprising a first medium and a second medium, and the means for controlling the operation of the tool comprises means for detecting a transition from the first medium to the second medium.

11. The system as recited in claim 10, wherein the means for detecting the transition from the first medium to the second medium comprise means for detecting a variation in one of the operating parameter and the frequency of the operating parameter.

12. The system as recited in claim 1, wherein the operational parameter comprises one of linear displacement, linear velocity, linear acceleration, rotation, rotational velocity, rotational acceleration, force, torque, and sound.

13. The system as recited in claim 1, wherein the tool comprises one of a drill, a saw, an awl, a reamer, a lathe, a mill, an auger, and a broach.

14. A method for controlling operation of a tool, the method comprising:

detecting at least one operational parameter of the tool;

generating a signal representing the at least one operational parameter;

processing the at least one signal to detect at least one frequency of the operational parameter; and

controlling the operation of the tool in response to the at least one frequency of the operational parameter.

15. The method as recited in claim 14, wherein processing the at least one frequency comprises processing a plurality of frequencies.

16. The method as recited in claim 14, wherein processing the at least one signal to detect the at least one frequency comprises processing the at least one signal using software adapted to determine the frequency of the at least one operational parameter.

17. The method as recited in claim 14, wherein controlling the operation of the tool comprises detecting the activity of at least one of the operational parameter and the frequency of the operational parameter.

18. The method as recited in claim 17, wherein detecting the activity of at least one of the operational parameter and the frequency of the operational parameter comprises detecting a numerical characteristic of at least one of the operational parameter and the frequency of the operational parameter.

19. The method as recited in claim 18, wherein detecting the numerical characteristic comprises detecting at least one of amplitude, mean, variance, standard deviation, and spectral energy density.

20. The method as recited in claim 18, wherein controlling the operation of the tool comprises comparing the numerical characteristic to a threshold value for the numerical characteristic.

21. The method as recited in claim 1, wherein controlling the operation of the tool comprises at least one of stopping the operation of the tool, slowing the advancement of the tool, stopping the advancement of the tool, and moving the tool.

22. The method as recited in claim 1, further comprising operating the tool on a work piece comprising a first medium and a second medium, and wherein controlling the operation of the tool comprises detecting a transition from the first medium to the second medium.

23. The method as recited in claim 22, wherein detecting the transition from the first medium to the second medium comprises detecting a variation in one of the operating parameter and the frequency of the operating parameter.

24. The method as recited in claim 14, wherein the operational parameter comprises one of linear displacement, linear velocity, linear acceleration, rotation, rotational velocity, rotational acceleration, force, torque, and sound.

25. The method as recited in claim 14, wherein the tool comprises one of a drill, a saw, an awl, a reamer, a lathe, a mill, an auger, and a broach.

26. A system for controlling operation of a surgical drill on a bone, the system comprising:

a sensor adapted to detect at least one operational parameter of the drill and outputting at least one signal representing the at least one operational parameter;

means for processing the at least one signal to detect at least one frequency of the operational parameter; and

means for controlling the operation of the surgical drill in response to the at least one frequency of the operational parameter.

27. The system as recited in claim 26, wherein the bone comprises a first medium and a second medium, and wherein the system further comprises means for detecting a transition from the first medium to the second medium.

28. The system as recited in claim 27, wherein the means for controlling the operation of the surgical drill comprises at least one of means of stopping the operation of the drill, means for slowing the advancement of the drill, means for stopping the advancement of the drill, means for retracting the drill, and means for advancing the drill.

29. The system as recited in claim 27, wherein the first medium comprises trabecular bone and the second medium comprises cortical bone.

30. The system as recited in claim 26, wherein the operational parameter comprises one of linear displacement, linear velocity, linear acceleration, rotation, rotational velocity, rotational acceleration, force, torque, and sound.

31. The system as recited in claim 26, wherein the operational parameter comprises drill bit linear acceleration, and wherein the means for controlling comprises means for controlling the operation of the drill in response to a frequency spectrum of the drill bit linear acceleration.

32. The system as recited in claim 31, wherein the means for controlling the operation of the drill in response to the frequency spectrum of the drill bit linear acceleration comprises means

for controlling the operation of the drill in response to the detection of at least one predetermined frequency of the linear acceleration.

33. The system as recited in claim 32, wherein the means for controlling the operation of the drill comprises means for controlling the operation of the drill in response to activity of one of the linear acceleration and the frequency of the linear acceleration at the at least one predetermined frequency of the drill bit linear acceleration.

34. The system as recited in claim 33, wherein the activity comprises one of amplitude, mean, variance, standard deviation, and spectral energy density.

35. A method for controlling operation of a surgical drill on a bone, the method comprising:

detecting at least one operational parameter of the drill and outputting at least one signal representing the at least one operational parameter;

processing the at least one signal to detect at least one frequency of the operational parameter; and

controlling the operation of the surgical drill in response to the at least one frequency of the operational parameter.

36. The method as recited in claim 35, wherein the bone comprises a first medium and a second medium, and the method further comprises detecting a transition from the first medium to the second medium.

37. The method as recited in claim 36, wherein controlling the operation of the surgical drill comprises at least one of stopping the operation of the drill, slowing the advancement of the drill, stopping the advancement of the drill, retracting the drill, and advancing the drill.

38. The method as recited in claim 36, wherein the first medium comprises trabecular bone and the second medium comprises cortical bone.

39. The method as recited in claim 35, wherein the operational parameter comprises one of linear displacement, linear velocity, linear acceleration, rotation, rotational velocity, rotational acceleration, force, torque, and sound.

40. The method as recited in claim 35, wherein the operational parameter comprises drill bit linear acceleration, and wherein controlling the operation comprises controlling the operation of the drill in response to a frequency spectrum of the drill bit linear acceleration.

41. The method as recited in claim 40, wherein controlling the operation of the drill in response to the frequency spectrum of the drill bit linear acceleration comprises controlling the

operation of the drill in response to the detection of at least one predetermined frequency of the linear acceleration.

42. The method as recited in claim 41, wherein controlling the operation of the drill comprises controlling the operation of the drill in response to activity of one of the linear acceleration and the frequency of the linear acceleration at the at least one predetermined frequency of the drill linear acceleration.

43. The method as recited in claim 42, wherein the activity comprises one of amplitude, mean, variance, standard deviation, and spectral energy density.

44. A method for controlling operation of a tool, the method comprising:

detecting an operational parameter of a tool;

determining a characterizing value of the operational parameter at a pre-defined frequency;

comparing the characterizing value to a pre-defined threshold value of the characterizing value;

controlling the operation of the tool based upon the comparison of the characterizing value to the threshold value.

45. The method as recited in claim 44, wherein the characterizing value comprises a characterizing value of one of the operational parameter and the frequency of the operational parameter.

46. The method as recited in claim 45 wherein the characterizing value comprise one of amplitude, mean, variance, standard deviation, and spectral energy density.

47. The method as recited in claim 44, wherein controlling the operation of the tool comprises at least one of stopping the operation of the tool, slowing the advancement of the tool, stopping the advancement of the tool, retracting the tool, and advancing the tool.

48. A method for identifying a material being acted on by a tool, the method comprising:

defining at least one threshold value for a characterizing value of an operational parameter at at least one frequency for at least one material;

acting on the material with the tool;

detecting an operational parameter of the tool;

determining at least one characterizing value of the operational parameter at the least one predefined frequency; and

comparing the characterizing value with the at least one threshold value to identify the material.

49. The method as recited in claim 48, wherein the characterizing value comprises one of a characterizing value of one of the operational parameter and the frequency of the operational parameter.

50. The method as recited in claim 49, wherein the characterizing value comprises one of amplitude, mean, variance, standard deviation, and spectral energy density.

51. The method as recited in claim 48, wherein defining at least one threshold for at least one material comprises defining a threshold value for a plurality of materials.

52. An instrumented adapter for a tool comprising:

a cylindrical main body;

means for mounting the tool to the cylindrical main body;

means for mounting the main body to a motive force provider for the tool; and

a sensor mounted to the cylindrical main body, the sensor adapted to detect at least one operational parameter of the tool and to output a signal representative of the at least one operational parameter.

53. The instrumented adapter as recited in claim 52, wherein the means for mounting the tool comprises an adjustable chuck.

54. The instrumented adapter as recited in claim 52, wherein the means for mounting the motive force provider to the main body comprises a cylindrical projection engagable by the motive force provider.

55. The instrumented adapter as recited in claim 52, wherein the sensor is mounted one of on and in the cylindrical main body.

56. The instrumented adapter as recited in claim 52, wherein the sensor is adapted to output a signal via one of telemetry and wires.

57. The instrumented adapter as recited in claim 52, wherein the means for mounting the main body to the motive force provider is opposite the means for mounting the tool.

58. The system as recited in claim 4, wherein the software adapted to determine the frequency of the at least one operational parameter comprises a Fourier Transform.

59. The method as recited in claim 16, wherein the software adapted to determine the frequency of the at least one operational parameter comprises a Fourier Transform .

60. The system as recited in claim 1, wherein the system further comprises means for detecting the depth of penetration of the tool.

61. The system as recited in claim 60, wherein the means for detecting the depth of penetration of the tool comprises a linear variable differential transformer.

62. The system as recited in claim 1, wherein the system further comprises means for detecting the orientation of the tool.

63. The system as recited in claim 62, wherein the means for detecting the orientation of the tool comprises one of an accelerometer and an inclinometer.